

Deep Learning Based Gujarati Handwritten Character Recognition

¹Dhara S. Joshi, ²Yogesh R. Risodkar

¹ME Student, ²Assistant Professor

Department of Electronics and Telecommunication Engineering,
Sandip Institute of Technology and Research Centre, Nashik, Maharashtra, India
Savitribai Phule Pune University, Pune
¹dhara.joshi0324@gmail.com, ²yogesh.risodkar@sitrc.org

Abstract—Optical character recognition is a method of the renovation of pictures of printed text, handwritten documents and typewritten documents into a document recognized by the machine. This can be used for editing, reduction in storage space etc. So, basically, it relates to possess of teaching and recognition of data. Hence, here a hand written document which is in a form of some local language characters except than English. In this paper, we are using the Gujarati Characters for the recognition into the machine editable format. Deep learning is the method used for identity recognition which will depend on the man-made neural network. Deep learning involves a proper focus on right features of the image to recognize themselves with a negligible assistance from the program. Neural network evolved considering the concept of biological neurons. Accuracy and efficiency are improved by use of deep learning for character recognition.

Keywords— Deep learning, optical character recognition, edge detection, K-NN, NNC, python, open CV.

I. INTRODUCTION

Gujarati script comes from the favorite Devanagari script. The Gujarati terminology is popularly employed by more than 50 million individuals mainly by Gujarati people in the talk about Gujarat from India and worldwide as Gujarati people are domicile of several countries. Today technology is spanned in a very competitive manner all around the globe. The cheap price of internet and computer has given acceleration to attain every place in the world. Today almost all of documents systems in government office buildings or all over is text-based mostly. Massive amount documents and books are in printed out words format or in scanned format. You can find need of some useful method that can identify people from the paper scanned documents. Your personal computer system that acknowledges character types from a scanned image or record and can process automatically is named Optical Character Recognition system. Among the initial strategy is Design template matching technique.

Many latest models are designed by researchers concentrating on a particular problem for a particular script. For instance, some of the simplest like Design template Matching, K- nearest neighbor, Support Vector Machine,

HMM and different other models are developed. If the Artificial Neural network is employed in the field of pattern and figure recognition than it will be possible to build up a model from existing models that can learn itself and then recognize the raw scanned image. Self-learning systems are always complicated in design and execution but have great efficiency. Though design and structure of model may differ greatly predicated on the structure of the script.

K-nearest neighbor (K-NN) Classifier is a trusted methodology in OCR field. In template matching each persona is weighed against a set of layouts and the best matching effect is given in output. Compared to the post-processing phase converts productivity into standard text message format.

II. RELATED WORK

Datt and Amin[1] analyzed Gujarati handwritten characters using the Artificial neural network. Errors were corrected by RBPN (Radial Basis Probabilistic Neural Network) method. Also, the OCR is the technology which provides the fast and automated data capture which helps to save the time as well as cost too. Due to high noise tolerance, the artificial neural network is most commonly used. Image acquisition, processing, segmentation, feature extraction, classification and recognition, post-processing these are the basic step which involved in the OCR.

Chandarana and Kapadia [2] compared handwritten optical characters of different fonts with standard ones by using the techniques Feature extraction, Segmentation, Template matching and co-relation. Recognition accuracy observed was 91.16% when the number of images was tasted under the experiment which was better as compared to previous ones. Its recognition is strongest on monotype and different types of fonts considering the sample input images.

Patel and Desai [3] used cross types approach predicated on tree classifier and k-Nearest Neighbor (k-NN) for identification of handwritten Gujarati characters. Combination of structural features and statistical features is used for classification and identification of characters. The features are relatively simple to derive. The structural features are selected by studying the appearance of various handwritten characters. Combination of structural features and

statistical features is used for classification and identification of characters. The structural features were selected by studying the appearance of various handwritten characters of Gujarati script. A success rate of 63% was achieved using this approach.

Sojitra and Dhakad [4] preferred the algorithm Neural Network, Self-organizing map and the classifier used is a nearest neighbor classifier. The analysis was carried with ten input samples and five different fonts. 50 samples are collected for a single character of Gujarati script. Accuracy found was 97.78% and recognition rate for slight changes in the training set was found 98.83%. The results state that pre-processing of data before giving input to K-nn has given highest recognition rate. Merging Neural with existing methods for recognition has given optimum results and best recognition rate. The comparison is performed on a pixel by pixel basis.

Prasad and Kulkarni[5] are stated that the recognition rate image is highly affected by the similarity of various characters, and these characters which can be verified with some recognition rates of Class 2, 3 and 4. In this classes, there are more similar characters which in turn degrade and recognition rate. It classified the Gujarati Character set into 6 classes, which is based on their geometrical shapes. An average overall Recognition Efficiency of 71.66 %. For recognition, an evaluation was done for each letter in the learning set and efficiency of recognition was evaluated for each letter.

III. ATTRIBUTES OF GUJARATI SCRIPT

Gujarati is phonetic dialect in European India. Gujarati content is composed of kept to ideal, with every persona speaking to a syllable. The type group of Gujarati script contains 12 vowels, that happen to be called Swar and 34 consonants that are called Vyanjan. For this project, created own dataset of Gujarati characters and vowels.

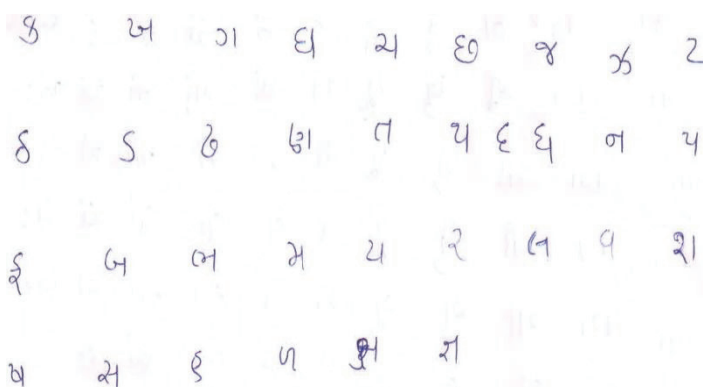


Fig. 1. Gujarati Characters

Gujarati contain agroup of special modifier icons called Maatras, related to each vowel, that is mounted on consonants to improve their sound.



Fig. 2. Gujarati Vowels

IV. OPTICAL CHARACTER RECOGNITION

OCR(optical character recognition) belongs to agroup of skills implementing certain recognition. OCR is requisite when data should be understandable to both humans and machinery and another possible input can't be predefined. By comparing in a manner with necessary recognition, OCR is special in which it doesn't want control of the process which produces the data. OCR deals with the issue of identifyingoptically processed characters. Optical verification is performed offline after writing or printing has been completed, as opposed to online verification where computer verifies the characters as they drawn. Handwritten and printed both the characters may be verified, but the performance directly depends on the quality of the input data.

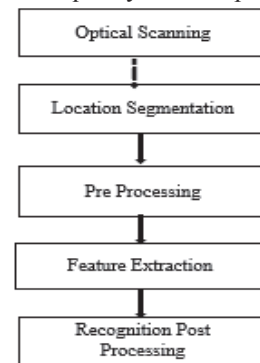


Fig.3.Components of OCR

If the input is stronger, then the OCR system also becomes so powerful. Be that as it may, with regards to absolutely unconstrained penmanship, OCR machines are as yet far from perusing and also people. Nonetheless, the PC peruses quick and specialized advances are ceaselessly conveying the innovation nearer to its optimal.

V. PROPOSED METHODOLOGY

The great thing about K-NN method compared to other classifier is that it is simple & effective, new data cases can be added easily in training place for future classification, not require preceding training, But the downside of K-NN are, when the knowledge is categorical it is difficult to compute the space between two cases. CPU cycle absorption and time ingestion vary linearly with increasing size of training data. Scripts like Gujarati where consonants, have washers, maatras will quite complex and aggravating execution of K-NN. For the process the classifier used is Nearest Neighbour Classifier.

A. DEEP LEARNING :

Deep Learning is a branch of machine learning which is based on Artificial Neural Network. Deep learning models are capable to focus on the right features by themselves, requiring the little guidance from the programmer. These models partially solve the dimensionality problem. If there are very large numbers of inputs and outputs, one can use the Deep Learning. It is used to imitate human behavior. Deep Learning is implemented with the help of Neural Network and

the motivation behind this Neural network is the Neurons. A collection of statistical machine learning techniques used to learn feature hierarchies based on the artificial neural network.

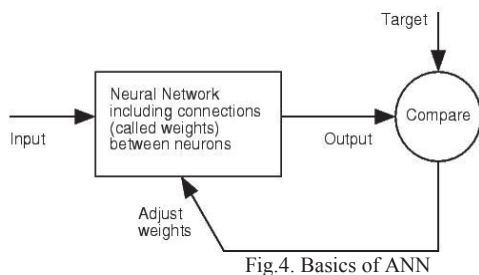


Fig.4. Basics of ANN

B. PROPOSED SYSTEM :

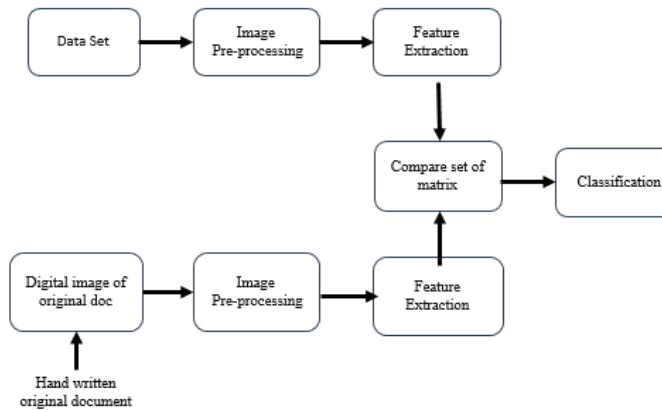


Fig.5. Block Diagram of Proposed System.

The proposed system is shown below. As per requirement for the system design, one has designed the proposed system.

➤ DATA SET :

The image is acquired by the offline or online method. Offline uses scanner or camera whereas online uses digital pen/stylus. `cv2.imread()`: This function is available to read the image from the folder. We have to provide a valid path to function for successful reading of the image. We can read multiple images from multiple folders using this function. By specifying folder's path.

➤ IMAGE PREPROCESSING :

Pre-processing is required before feature extraction and classification phase to improve image quality. Pre-processing includes some operations like:

- RGB to gray conversion



Fig.6. RGB to Gray Conversion

RGB image's each pixel contains three different intensity values of RED, GREEN, BLUE color components. Grayscale images contain single intensity value between 0-256 for each

pixel. Processing is more complex on RGB images than Grayscale images.

- Skew correction

The angle of documents make with the horizontal lines is called skew angle, which can be corrected by filtering.

- Filtering

Some noise present in the Images due to the scanner, the age of the document, etc. So we have to apply some filtration operation.

There are different types of filters like:

- **Average filter** (It takes averages of all pixel values under kernel area)
- **Gaussian filter** (remove Gaussian noise by using Gaussian kernel)
- **Median filter** (It takes medians of all pixel values under kernel area)
- **Bilateral filter** (it reduces noise and preserves the edges, but slower operation)

- Morphological operation (Dilation, Erosion, opening, closing, etc.). :

Handwritten characters have some illegal breaks due to people's different method of writing. So it causes false recognition.

A different morphological function like:

- **Dilation** (increases boundary of foreground image or white region increases)
- **Erosion** (opposite of the dilation process)
- **Opening** (similar to erosion followed by dilation)
- **Closing** (opposite of the opening process)

Morphological operation improves recognition rate by removing this uncertainty in characters.

➤ FEATURE EXTRACTION

The main aim of feature removal is to eliminate redundancy from data. The duty of human being expert is to choose features that allow effective and useful recognition of design. The feature removal evolves the thinning and skeletonization of the image. Feature removal is essential in reputation system since it is employed by the classifier to classify the information.

➤ ALGORITHM :

The Algorithm used for the system is KNN. In pattern identification, k-NN is a non-parametric method used for classification and regression. In both circumstances, the input contains the k closest training instances in the feature space. The productivity will depend on whether k-NN is employed for classification or regression. The Pseudo code for the K-NN is shown below.

VII. CONCLUSION

After the detailed study and the analysis, it is found that the proposed system is useful. This is because of its good accuracy nearby 78.6% and the desired time. Filtering, edge detection, morphological transformation etc., these algorithms are to be used in the feature extraction. To develop the system, Python and open CV libraries for the programming purpose are utilized. The classifiers which are useful for the classification are K-NN, NNC etc. From all these methods, convenient solution for the analysis is obtained.

REFERENCES

- [1] S. Rishi Kumar¹, G.Madhavan¹, M. Naveen¹, S.Subash¹, U. Selvamalar Beulah Ponrani², Dept of Electrical and Electronics Engineering, Velammal Engineering College, "Image Processing based Multilingual Translator for Travellers using Raspberry Pi"2017
- [2] Sagar S.Dutt, Prof. Jay D.Amin Student of Gujarat Technological University, Assistant Professor at L. J. Institute Of Engineering &Technology, "Handwritten Gujarati text recognition using artificial neural network and Error correction using Probabilistic Neural network in recognized text "2016
- [3] Chhaya Patel MCA Department Anand Institute of Information Science, Anand, India 2 Apurva Desai Department of Computer Science, Veer Narmad South Gujarat University, "Gujarati Handwritten Character Recognition Using Hybrid Method Based On Binary Tree-Classifer And K-Nearest Neighbour"2014
- [4] Jagruti Chandarana¹, Mayank Kapadia² 1Department of Electronics and Communication Engineering UKA TARSADIA University, "Optical Character Recognition" 2014
- [5] Jagruti Chandarana, Mayank Kapadia² Optical Character Recognition¹,iterate, (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 5, May 2014)
- [6] Jatin M Patil, Ashok P. Mane, "Multi-Font and Size Optical Character Recognition Using Template Matching" International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 1, and January 2013.
- [7] Jayashree R. Prasad Dr. U.V.Kulkarni Dean, Academics SGGGS Institute of Technology 3 Rajesh S. Prasad, "Offline Handwritten Character Recognition of Gujarati Script using Pattern Matching"2013
- [8] BRIJESH SOJITRA, vishnukumar DHAKAD,Kautilya Institute of Technology & Engineering, Rajasthan Technical University, Jaipur, Rajasthan, India, "NEURAL NETWORK IN CHARACTER RECOGNITION OF GUJARATI SCRIPT"2013
- [9] M. Zahid Hossain_ M. Ashraf Amin, Hong Yan, "Rapid Feature Extraction for Optical Character Recognition", Manuscript Draft, June 4, 2012.
- [10] Sanghamitra Mohanty, Himadri Nandini Das Bebartta, "Performance Comparison of SVM and K-NN for Oriya Character Recognition", International Journal of Advanced Computer Science and Applications (IJACSA), Special Issue on Image Processing and Analysis, pp.-112-116, 2011
- [11] https://www.youtube.com/watch?v=dafuAz_CV7Q

Let (X_i, C_i) where $i = 1, 2, \dots, n$ be data points. X_i denotes feature values & C_i denotes labels for X_i for each i .
Assuming the number of classes as 'c'
 $C_i \in \{1, 2, 3, \dots, c\}$ for all values of i
Let x be a point for which label is not known, and we would like the label class using k-nearest neighbor algorithms.

Fig.7.Pseudo code for K-NN

➤ CLASSIFIER :

- Calculate " $d(x, x_i)$ " $i = 1, 2, \dots, n$; where d denotes the Euclidean distance between the points.
- Arrange the calculated n Euclidean distances in non-decreasing order.
- Let k be a +ve integer, take the first k distances from this sorted list.
- Find those k -points corresponding to these k -distances.
- Let k_i denotes the number of points belonging to the i^{th} class among k points i.e. $k \geq 0$
- If $k_i > k_j \forall i \neq j$ then put x in class i .

Fig.8. K-NN classifier process

VI. RESULT AND DISCUSSION

The results are on the basis of Feature Extraction, Classifiers, Accuracy and time. Therefore the final results will be based on the algorithm used, classifiers used, hence the output parameters may vary. The feature extraction techniques used are edge detection, filtering, morphological transformation etc, the classifiers may use are K-NN or NNC. The tabular form of outcomes is shown below.

TABLE 1. Outcomes

Sr. No.	Type of Database	Feature Extraction	Classifier	Accuracy	Time
1	Handwritten Images (set of 10 dataset)	Edge Detection	NNC	74.26%	50 sec.
2	Set of 20 datasets	Filtering	K-NN/NNC	79.83%	40sec
3	Set of 30 Dataset	Morphological Transformation	K-NN	82.03%	60sec.